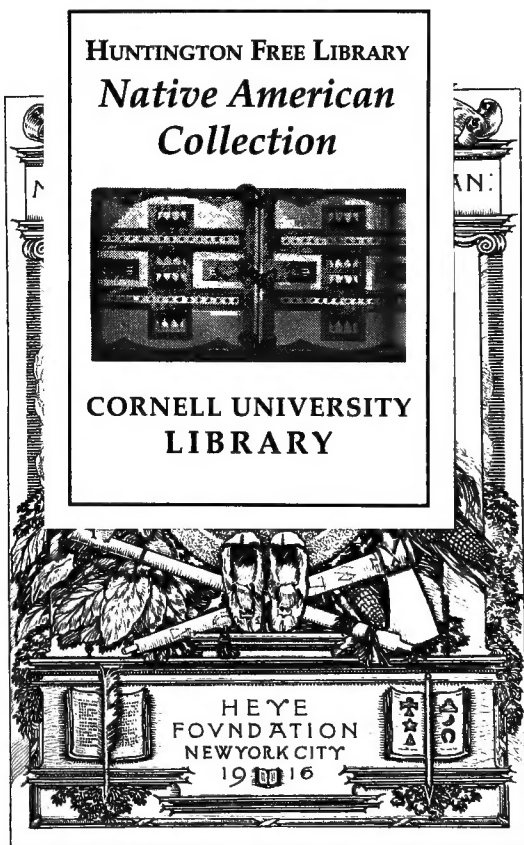


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FOOD PLANTS OF ANCIENT AMERICA.

BY

O. F. COOK,
U. S. Department of Agriculture.

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FOOD PLANTS OF ANCIENT AMERICA.^a

By O. F. COOK,
U. S. Department of Agriculture.

Agricultural science so generally appears as a borrower from physics, chemistry, botany, or zoology that it has not been expected to furnish facts of use in other lines of investigation. Thus, although it has been known since the sixteenth century that the same primitive food plants were cultivated throughout the tropics of both hemispheres, the significance of this remains unappreciated, and there is still doubt and speculation regarding prehistoric communication across the Pacific. Alaskan land connection, Buddhist missionaries, stranded Japanese junks, and other possibilities of a northwestern contact have been gravely and minutely discussed, while unequivocal evidence of tropical intercourse lay only too obviously at hand. The cultivation of the same seedless plants, such as the yam, sweet potato, taro, sugar cane, and banana by the primitive peoples of the islands of the Pacific, as well as by those of the adjacent shores of Asia and America, indicates, with attendant facts, not only an older communication but an intimate contact or community of origin of the agricultural civilizations of the lands bordering upon the Pacific and Indian oceans. Concrete biological data need not be disregarded because the peopling of America by the lost tribes of Israel and other equally fanciful conjectures are discredited.

THE CULTIVATED PLANTS OF THE PACIFIC ISLANDS.

Notwithstanding the immense distances by which the tropical islands of the Pacific are separated from the continents and from each other, European discoverers found them already occupied by an adventurous, sea-faring people who knew enough of the stars, trade winds, and currents to navigate their frail canoes in those vast expanses of ocean without the mariner's compass. The agriculture of the Polynesians was, however, no less wonderful than their seamanship, and was certainly not less important to them, since the coral islands of the Pacific are not only deficient in indigenous plants and animals suitable for food, but the natural conditions are distinctly unfavorable to agriculture.

^a Revision of article on The American Origin of Agriculture, in *Popular Science Monthly*, October, 1902.

"The whole surface of these flat coral islands is like the clean white sanded floor of an old English kitchen. The cocoanut tree springs up everywhere, but in the spots where yams and taros are grown the sand is hollowed out and a pit formed, from 100 to 200 yards long and of varying width, into which decaying cocoanut leaves and refuse are thrown till a rich soil is formed."^a

"The position occupied by the Polynesian races as tillers of the soil has hardly had sufficient attention given to it, although it may be doubted whether any people ignorant of the uses of the metals ever advanced so far as they have done. * * * Let any one read the account given by the first visitors to New Zealand—especially Cook—respecting the Maori cultivations of those days—the care that was taken to keep them free from weeds; the labor expended in conveying gravel to hill up the kumara plantations; the trouble taken to protect them from the strong winds by means of temporary screens or fences; the months employed in building houses (often highly carved and decorated) in which to store their crops; the amount of patient care and selection required in raising new varieties."^b

The agricultural achievements of the Polynesians become even more impressive when we reflect that so many of their cultivated species were not propagated from seeds but from cuttings. These must have been carefully packed, kept moist with fresh water, and protected against the salt spray, to survive the long voyages in open canoes. A list of 24 species of plants believed to have been brought to the Hawaiian Islands by prehistoric colonists is given by Hillebrand.^c This number, however, must be greatly increased, since there were many varieties of the sweet potato, taro, sugar cane, and banana. Moreover, the Hawaiian group is scarcely more than subtropical in climate, and lacks numerous seedless sorts of the breadfruit, yam, taro, and other plants of the equatorial belt of islands, so that a complete enumeration of the species and varieties carried about by the early Polynesians among the islands of the Pacific would include nearly 100.

There are many indications to be drawn from the people themselves, as well as from the abundance of ancient ruins, that the archipelagoes

^a Moresby, *Discoveries and Surveys of New Guinea*, p. 73, London, 1876. The volcanic islands of Polynesia have, of course, rich soil, but they shared the deficiency of native food plants, so that nonagricultural people could scarcely have secured a permanent food supply.

It is certain, moreover, that among the Polynesians the cocoanut is a cultivated plant no less than the yam, taro, sweet potato, sugar cane, banana, breadfruit, and numerous other species found in use throughout the tropical islands of the Pacific. An especial interest attaches to the cocoanut in that there are adequate botanical reasons for believing that it originated in America, the home of all related palms. See *The Origin and Distribution of the Cocoa Palm*, Contributions from the U. S. National Herbarium, Vol. VII, No. 2, Washington, 1901.

^b Cheeseman, *Trans. New Zealand Inst.*, 33:307-308. 1901.

^c *Flora of the Hawaiian Islands*, *Introd.*, p. xvi, 1888.

of the Pacific were the scene of a former civilization much more advanced than that found by Europeans. Seamanship, like other arts, had declined, and communication with the remoter islands like Hawaii, Easter Island, and New Zealand had been interrupted for several centuries, perhaps as a result of an intermixture of the so-called Melanesians, the native black race of New Guinea and neighboring islands of the western Pacific, peoples inferior in agriculture, seamanship, and social organization. In spite of the richer native flora of the Melanesian islands, no cultivated plant of importance seems to have been domesticated there, no species being reported as in cultivation among the Papuans which is not shared with the Malays to the west or with the Polynesians to the east, and in nearly all cases with both.

The primitive agriculture of all the Pacific islands may be viewed, then, as a connected whole, and a detailed study of the origins, present distributions, native names, agricultural methods, and domestic uses of the numerous species and varieties of cultivated plants may be expected to yield the most definite information now obtainable regarding the origins and migrations of the ancient agricultural peoples of the Tropics.^a At present we have only incomplete and scattered data collected incidentally by missionaries, travelers, and professional botanists who did not appreciate their opportunities from the agricultural point of view. But even these miscellaneous facts are often of unexpected interest. Thus, we know that in Central America the use of leguminous shade trees in cacao plantations was adopted by the Spanish colonists from the natives, who furnished even the name, "mother of cacao," by which the species of *Erythrina* and other leguminous shade trees are still known in Spanish America. The Indians, of course, were not aware that the roots of the leguminosæ developed tubercles for the accommodation of bacteria able to fix atmospheric nitrogen in the soil, and thus increase its fertility. They believed that the "madre de cacao" supplied water to the roots of the cacao, a fanciful idea still credited by many planters, and not much improved upon by the current notion that shade of large trees is beneficial to cacao and coffee. In the Pacific we encounter a similar fact with reference to the yam bean (*Pachyrhizus*), a leguminous vine with a fleshy edible root. The natives of the Tonga Islands no longer cultivate *Pachyrhizus* for food, but they nevertheless encourage its growth in their fallow clearings in the belief that it renders them the sooner capable of yielding larger crops of yams. Such anticipations of the results of modern agricultural science are of extreme interest, but it is still uncertain whether similar knowledge exists in other archipelagos of the Pacific, or on the American continent where *Pachyrhizus*

^a Even the cosmopolitan tropical weeds are worthy of careful study from this standpoint. After excluding aquatic, swamp-land, and strand species, Seeman found 64 genuine weeds in Fiji, of which 48 were common to America, while only 16 were held to be Old World species.

probably originated. The botanists report it as "a common weed in cultivated grounds," and we learn further that, in the absence of better material, the people of Fiji use the fiber for fish lines, and that the plant sometimes figures in an unexplained manner in their religious ceremonies, an indication of greater importance in ancient times.

Our knowledge is far from complete regarding even the present distribution of the principal tropical food plants, but the need of further investigation should not obscure the striking fact that several of the food plants with which the Spaniards became acquainted in the West Indies were also staple crops on the islands and shores of the Pacific and Indian Oceans, and even across tropical Africa.

How this very ancient agricultural unity of the Tropics came about may be unexplainable by history or tradition, but it is scarcely more mysterious than that so significant a fact should have been disregarded so long in studies of primitive man. Our attitude, even yet, seems to be that of the mediæval Europeans, who believed with Columbus that the newly discovered "Indies" of the western Atlantic were the same as those of eastern Asia. Nearly a century elapsed between the discovery of America and the realization that it was indeed a new world and not merely an eastern prolongation of Asia, so that the community of food plants in regions separated by more than half the circumference of the globe did not at first appear remarkable. Modern geography has proved the remoteness of the localities, but modern biology gives no less definite testimony that the same plant does not originate twice, and makes it plain that varieties dependent everywhere for their very existence on human care must also have been distributed by human agency.

THE AGRICULTURE OF ANCIENT AMERICA.

The most important food plants of the Polynesians were seven in number—the taro, yam^a, sweet potato, sugar cane, banana, breadfruit, and cocoanut—of which six, or all except the breadfruit, existed in pre-Spanish America, and of these, five, or all except the cocoanut, were propagated only from cuttings.

Except with the banana, botany gives us much evidence for and none against the New World origin of the food plants shared by ancient America with Polynesia and the tropics of the Old World,

^a Numerous species of true yams (*Dioscorea*) are cultivated, and the roots of many wild species are collected for food in various parts of the Tropics. The present reference is to *D. alata*, the most widely distributed of the domesticated species and not known in the wild state.

"The Haitian name of the *Dioscorea alata* is *aves* or *ajës*. It is under this denomination that Columbus describes the *igname* in the account of his first voyage; and it is also that which it had in the times of Garcilasso, Acosta, and Oviedo, who have very well indicated the characters by which the *aves* are distinguished from *batates*."—Humboldt, Kingdom of New Spain, vol. 2, p. 355. Trans. by Black, New York, 1811.

though few of them are known under conditions which warrant a belief that they now exist anywhere in a truly wild state. The partial or complete seedlessness attained by several of the important species also indicates dependence upon human assistance in propagation for a very long period of time, and precludes all rational doubt that their wide dissemination was accomplished through the direct agency of primitive man.

Ethnologists will not deny that in the Old World this distribution was the work of the remote ancestors of the Polynesians, traces of whose presence have been found distributed over the area included between Hawaii, Easter Island, New Zealand, Formosa, Malaya, Madagascar, and even across the African continent.^a We have not been provided, however, with any explanation of the existence of these food plants in America, for ethnologists do not admit that the eastward migrations of the Polynesians reached this continent, but hold that the tribes, languages, customs, and arts of the American Indians are of truly indigenous development, not imported from Asia or elsewhere, as so frequently and variously conjectured.

"I maintain, therefore, in conclusion, that up to the present time there has not been shown a single dialect, not an art nor an institution, not a myth or religious rite, not a domesticated plant or animal, not a tool, weapon, game, or symbol, in use in America at the time of the discovery, which had previously been imported from Asia or from any continent of the Old World."^b

If this conclusion be adopted it is obvious that the food plants common to the two hemispheres must have been derived from America. This alternative seems not to have been canvassed with the standpoint and methods of modern ethnology, but it is safe to say that in Asia no-

^aFrobenius, *Zeitsch. der Gesellsch. für Erdkunde zu Berlin*, Bd. 33, 1898. Report of the Smithsonian Institution for 1898, pp. 637-650.

^bBrinton, D. G., in *Memoirs of the International Congress of Anthropology*, p. 151, Chicago, 1894. The same argument has been stated somewhat less radically by Payne, but with no more adequate appreciation of the significance of the facts of tropical agriculture:

"If advancement was at some remote time imported from the Old World into the New, how happens it that at the discovery all the domesticated animals and nearly all the cultivated food plants of the Old World were either wanting or existed only in a wild state in the New World? * * * Pulse [the bean] was the only cultivated plant common to America and the Old World. * * * Civilized immigrants from Asia would naturally strike the New World in British Columbia or Oregon; and the doctrine of imported advancement finds its most decisive refutation in the fact that from the most remote until recent times agriculture was here absolutely unknown." Payne, *Hist. of the New World called America*, Vol. II, p. 340-347.

It is possible that there were no Old World cultivated plants in America except the banana, which evidently arrived late. That Asiatic agriculture was not introduced into America is, however, far from proving that American agriculture was not introduced into Asia.

such arguments can be made as in America against the exotic origin of the earliest civilizations. It is a simple zoological fact, also freely admitted by ethnologists, that the straight-haired Malayoid peoples are not the original inhabitants of southeastern Asia and the neighboring islands, since throughout these regions there are isolated remnants and traces of earlier curl-haired types, such as the Negritos, Andamanese, Papuans and Ainus.^a

If it be reasonable to suppose that the food plants which the Polynesians shared with the tropical peoples of both continents were carried by them across the Pacific, it is also reasonable to seek the origin of these widely distributed species on the continent which gives evidence of the oldest and most extensive agricultural activity, and to the question in this form there can be but one answer. The agriculture of the Old World tropics is adequately explainable by the supposition that it was brought by the Polynesians, since the root crops of the Polynesians were also staples of the Old World tropics. This proposition would not apply to America, where, in addition to the sweet potato, yams, yam-bean (*Pachyrhizus*), canna and taro, which crossed the Pacific, the aborigines also domesticated a long series of root crops confined to America at the time of its discovery. Such are: *Manihot* (cassava), *Maranta* (arrowroot), *Calathea* (Ileren), *Solanum* (Irish potato), *Xanthosoma* (several species), *Oxalis* (oca), *Sechium* (chayote), *Tropaeolum*, (massua^b), *Ullucus*, *Arracacia*, and *Helianthus* (Jerusalem artichoke)^c all of considerable local importance.

The simplest of cultural methods, propagation from cuttings, was applied to these root crops and has been in use for so long a period that several of them have become seedless. With equal uniformity the distinctively Old World root crops are grown from seed. And as all the Asiatic and European species are of temperate origin and have not been greatly modified from their wild ancestral types, it is reasonable to believe that they were domesticated by peoples already accustomed to the planting of cereals, which are correctly viewed as the basis of temperate agriculture. Root crops of American origin belong to at least twelve natural families, and the only important Old World addition to the series is the mustard family, a distinctly temperate group, the cultivated members of which have not been greatly modified in domestication, and are still known in the wild state.

This apparent superfluity of American root crops is explainable by the fact the different plants were independently domesticated in differ-

^aScience, N. S., 15: 928-932. 1902.

^bMr. W. E. Safford notes that the word "māsoā" means, in the Samoan language, sticky or starchy and is applied to the Polynesian arrowroot (*Tacca pinnatifida*) a root crop of the Pacific islands. See Pratt, Samoan Dictionary, p. 211, 1893.

^cAll these root crops were propagated from cuttings except *Pachyrhizus*, *Canna*, and *Sechium*. Other seed-grown cultivated plants common to the two hemispheres were the coconut, bean, cotton, gourd (*Cucurbita*), and bottle gourd (*Lagenaria*).

ent localities, which means also that conditions favorable to the development of agriculture were very general among the natives of America. That most of these plants are not known in the wild state testifies also to the great antiquity of this agricultural tendency, while archæology shows the same antiquity and diversity of prehistoric civilizations in America. From the mounds of Ohio to the equally remarkable ruins of Patagonia, the American continents and islands are, as it were, dotted with remains of rudimentary civilizations which must have required centuries and millenniums to rise from surrounding savagery, culminate, and perish. The constructive arts by which the existence of these vanished peoples is made known took the most diverse forms; some made mounds, some expended their energies upon huge carvings on high, inaccessible rocks, some dug devious underground passages, some set up monoliths and carved statues, and some built massive platforms, terraces, pyramids, temples, and tombs, while still others are known only from their pottery or their metal work. In civilization, as in agriculture, the tropics of America stand in striking contrast to those of the Old World. Here men of the same race showed great diversity of plants and arts; there races are diverse, while arts and staple food plants are relatively little varied. The early civilizations of the eastern world resembled some of the primitive cultures of America more than these resembled each other.

The American origin of agriculture is thus not doubtful, since not merely one, but several, agricultures originated in America. The same can not be claimed for Asia and Africa, where only root crops shared with America attained a wide distribution, an indication that they reached those continents before the uses of the similar indigenous plants had been discovered.

POISONOUS ROOT CROPS.

The domestication of so many root crops in America indicates, as has been intimated, a widespread use of food of this kind before agriculture began, and many savage tribes still have recourse to wild roots, either as a staple article of diet, or in times of scarcity. It is evident, however, that the culture of the principal root crops of America was not begun as a simple and direct transition from the use of fruits, which are commonly supposed to have been the food of primitive man. The more ancient and more important of the Old World root crops, the onions, leeks, garlies, carrots, and radishes are eaten, or are at least edible, in the raw state, but in America there seems to be no indication that the natives used any root crop in this way. Some of them, such as the sweet potato, the artichoke and the "sweet cassava," can be eaten raw, but throughout the tropics of America the Indians, like the Chinese, prefer everything cooked. This habit must have been

adopted very far back to make possible the ancient domestication of *Manihot* (cassava), *Colocasia* (taro) and *Xanthosoma* (yautia), since the fleshy underground parts of these plants contain substances distinctly deleterious and extremely unpalatable until disintegrated and rendered harmless and tasteless by heat. The same may have been true of the sweet potato," since the fleshy roots of its uncultivated relatives are strongly purgative. Several of the yams, both wild and cultivated, are also poisonous in the raw state.

That these poisonous root crops were the most popular, widespread and ancient would seem to afford sufficient proof that the discovery of the use of fire in cooking preceded the development of the art of agriculture, though further support may be derived from the very practical consideration that without fire the primitive savage with his stone ax would make little headway in the work of clearing away the forest, which is everywhere the first preliminary of tropical agriculture.

To be able to utilize as nourishing food the natural supplies of starchy roots, which to other tribes were poisonous, would give the primitive fire users an important advantage over their neighbors, and would greatly conduce to the adoption of a settled existence in districts where the plants were plentiful. Cassava, yams, taro, sweet potatoes, and others of the primitive series of root crops often grow freely and without care from rejected fragments or pieces of stem, so that the digging of the roots and trampling down of the vegetation would not exterminate the wild supply, but would afford, on the contrary, abundant opportunity and encouragement for the gradual increase of cultural efforts.

A third important step in the domestic economy of primitive man was the making of dry meal or starch from roots, accomplished in the tropics of both hemispheres by similar processes of grating, soaking in water, boiling, or treating with alkalis to destroy their poisonous properties. Separated from the sugars and other readily soluble sub-

"A plant which may be the wild ancestral form of the sweet potato is a common weed in the Coban coffee district of eastern Guatemala. The absence of the sweet potato from Samoa, Fiji, Guam, and the Philippines may have inclined some to doubt its prehistoric distribution in the Old World west of Hawaii and New Zealand, but according to Bretschneider it is recorded in Chinese books of the second or third century of the Christian era, and there are many varieties with native names in tropical Africa, both east and west, and legends indicative of its presence in early times.

"It is told me as truth, that before the Portuguese came to this coast (Guinea), the negroes subsisted themselves with these two fruits (yams and sweet potatoes) and a few roots of trees, they being then utterly ignorant of *Millio* (maize), which was brought hither by that nation." (Bosman's *Guinea* (1698) in Pinkerton's *Voyages*, vol. 16, p. 459.)

Cheeseman records two varieties of the sweet potato as existing in *Rarotonga* before the arrival of Europeans, and believes that the plant has been cultivated there "from time immemorial." (Trans. Linn. Soc. Lond., 2 ser., 6:289, 1903.)

stances which retain or absorb moisture, the starch of the taro, cassava, arrowroot, canna, and other root crops can be quickly and thoroughly dried, and will then keep indefinitely. In the absence of cereals this simple expedient might well be deemed an epoch-making discovery, since it rendered possible the accumulation of a permanent, readily transportable, food supply, and thus protected man from the vicissitudes of the season and the chase. That the resulting economic difference appeared striking to the hunting tribes of Guiana is apparent in the name they gave to their agricultural neighbors, whom they called "Arawacks" or "eaters of meal."

Cassava in the raw state carries a deadly charge of prussic acid and begins to decay in a few hours after being taken from the ground, but properly prepared it furnishes the starch which keeps best, and which in the form of tapioca our civilization is tardily learning to appreciate as a wholesome delicacy. In spite of its unpromising qualities when raw, cassava seems to have been the first and only root crop used by many South American tribes who plant nothing else except the so-called peach palm (*Guilielma*), a species which gives suggestive evidence of a cultivation much older than that of the date palm, since it is generally seedless, and is not known in the wild state. The farinaceous fruits are made into meal and baked into cakes in the same manner as the cassava, to which recourse is necessary during the months in which the single harvest of palm fruits is exhausted.^a

Cassava is, indeed, so distinctively the best, as well as the most generously and continuously productive, of the tropical root crops, that it could hardly have been known in the regions in which the others were domesticated. Ever since the Spanish conquest put an end to the isolation of the native peoples of tropical America the use of cassava has been slowly extending at the expense of similar crops; it has also found a footing in the Malay region and other parts of the East.

THE DOMESTICATION OF THE BANANA.

In further support of the suggestion that the use of the starch-producing root crops is a distinctively American development of primitive agriculture is the fact that the tropics of the Old World contributed no important cultivated plant of this class, and none which give evidence of long domestication. On the other hand, such regions as Madagascar and East Africa, where Polynesians are now supposed by ethnologists to have settled in "remote prehistoric times," continued

^a Some of these tribes are extremely primitive and, in the absence of all domestic implements, grate their cassava on the exposed spiny roots of another native palm (*Iriarteia exorhiza*). Some Indian tribes of Guiana are similarly dependent upon still a third palm (*Mauritia*), from the pith of which they secure starch in a manner strongly suggestive of that used with the sago palm of the Malay region.

the culture and differentiation of the varieties of the taro and the sweet potato, and were agriculturally mere outposts of the American tropics.

The presence of the banana might be thought to explain the relatively small importance of root crops in the Old World, since it furnishes with far less effort of cultivation and preparation a highly nutritious and palatable food. It appears, however, that the use of root crops must have preceded the domestication of the banana, for, although the seed-bearing wild bananas are worthless as fruits and hence would not have been domesticated as such, nevertheless more species of them than of any other genus of food plants were brought into cultivation. The clue to this paradox is afforded by the fact that bananas are still cultivated as root crops in the Old World tropics, particularly in New Caledonia and Abyssinia.^a

That the varieties used like vegetables or root crops are as old or older than those grown for fruit is indicated by the fact that, like the sweet potato, taro, sugar cane, and ginger, they seldom produce flowers. Furthermore, among all savage tribes the varieties valued by civilized peoples as fruits are relatively little used, far greater popularity being enjoyed by the so-called "plantains," not edible in the raw state, even when ripe, though nearly always cooked and eaten while still immature, or before the starch has changed to sugar. They are also in many countries dried and made into a meal or flour often compared to arrowroot.

In dietary and culinary senses the breadfruit also is as much a vegetable as the taro or the sweet potato; as a fruit it would be no more likely to be domesticated than its distant relative, the osage orange. The farinaceous character of the breadfruit also probably explains its relatively greater importance among the Polynesians than in its original Malayan home, as shown by the propagation of numerous seedless varieties. The popularity of the breadfruit among the Polynesians was

^aThe suggestion that the primitive culture race which domesticated the banana came from America also receives definite support from the fact that an American plant (*Heliconia bihai*), somewhat similar to the banana but without an edible fruit, reached the islands of the Pacific in prehistoric times. Though no longer cultivated by the Polynesians, it has become established in the mountains of Samoa and in many of the more western archipelagoes. In New Caledonia the tough leaves are still woven into hats, but the *Pandanus*, native in the Malay region, affords a better material for general purposes and has displaced *Heliconia* in cultivation among the Polynesians. In the time of Oviedo the natives of the West Indies made hats, mats, baskets, and thatch from the leaves of *Heliconia*, and the starchy rootstocks were eaten.

Professor Schumann, of Berlin, has recently recognized the prehistoric introduction of *Heliconia bihai* from America to the Pacific Islands.

"Originally native in tropical America, but extensively naturalized since very ancient times (*uralten Zeiten*) in Polynesia and Malaysia." (Schumann und Lauterbach, *Die Flora der Deutschen Schutzgebiete in der Südsee*, 224, 1901.)

further extended by the discovery that the fruits could be stored in covered pits, the prototypes of the modern silo.

In Abyssinia the tender heart of the banana, there cultivated as a root crop, is fermented in a similar manner and then baked into cakes.^a

FROM ROOT CROPS TO CEREALS.

If the domestication of the banana is to be ascribed to cultivators of root crops, the same reasoning applies with even greater propriety to cereals. Tribes accustomed to subsist on mangoes, dates, figs, or similar fruits which require no grating, grinding, or cooking, and are eaten alone and not with meat, would not develop the food habits and culinary arts necessary to equip primitive man for utilizing the cereals.

Wild bananas and their botanical relatives are natives of the rocky slopes of mountainous regions of the moist tropics, where shrubs and trees prevent the growth of ordinary herbaceous vegetation. The commencement of the culture of cereals by fruit-eating natives of such forest-covered regions is obviously improbable, but would be a comparatively easy transition for the meal-eating cultivators of root crops, since the grasses and other plants domesticated for their seeds are exactly those which flourish in cleared ground and are prompt to take advantage of the cultural efforts intended for other crops. Thus the Japanese have by selection secured a useful cereal from the common barnyard grass (*Panicum crus-galli*), just as they have made a root crop of the burdock. Accordingly, we should look to some taro-growing tribe of southeastern Asia as the probable domesticators of rice, sesame, and Guinea corn. That root crops preceded cereals in America was inferred above partly from the fact that root crops were not there grown from seeds, and there is a corresponding indication that the knowledge of cereals preceded the domestication of the seed-grown temperate root crops of the Old World, since none of these is anywhere dried, made into starch, or otherwise prepared for storage as the basis of a permanent food supply of primitive tribes.

Without the winter protection which primitive man could not supply, the culture of cassava and other tropical root crops is confined to strictly tropical climates, so that increase of latitude and altitude would bring to starch-eating peoples the necessity of a change of food plants. Indeed, altitude seems to have played a larger part than latitude in this transformation which brought about the adoption by primitive American peoples of Indian corn, "Irish" potato, arracacha, oca, and other crops of the temperate plateaus of South America.

Without reasonable doubt, maize is the oldest of cereals. The large soft kernels which distinguish it from all other food grasses would render it easily available among the meal-eating aborigines of America,

^a Warburg, in Engler, *Deutsch Ost-Africa, Nutzpflanzen*, 100. 1895. In the lake regions of Central Africa the rootstocks of the fruit-bearing varieties of the banana are also pounded, dried, and made into meal, especially in times of scarcity.

and everywhere in tropical America maize is still prepared for food by methods adapted to root crops, and not ground dry and made into bread as a cereal, as among the Europeans who have colonized America. The rough stone slab (metate) against which the primitive Indian had rubbed his cassava and other farinaceous roots to a paste served also for maize, which is first softened by soaking in water with lime or ashes. The metate and the tortilla still hold their own in tropical America.

Like other species cultivated in the highlands of tropical America most varieties of maize do not thrive in moist equatorial regions of low elevations,^a so that it did not supplant the root crops, though having a far wider distribution than any other plant cultivated by the aborigines in pre-Spanish America. Nor did the utilization of maize mark the limit of cereal cultures in America, though no small-seeded crop of the New World compares in popularity with rice, wheat, barley, rye, and oats. Even in Mexico, the supposed home of maize, the seeds of *Amaranthus* and *Salvia* (chia) attained considerable economic importance. In addition to their use as food, the latter were made to furnish a demulcent drink and an edible oil valued as an unguent and in applying pigments, a series of functions closely parallel to those of sesame, perhaps the most ancient of Old World herbaceous seed crops. Wild seeds of many kinds were collected by the Indians of the United States and Mexico, including wild rice (*Zizania*) and *Uniola*, another rice-like, aquatic grass of the shallow shore water of the Gulf of California. In Chile there existed also several incipient cultures of small-seeded plants, such as *Madia*, while the people of the bleak plateaus of Peru and Bolivia had developed a unique cereal crop from a pigweed (*Chenopodium quinoa*), another of many evidences of a general tendency to agricultural civilization in ancient America.^b

^a The varieties of maize cultivated, for example, by the Indians of Guatemala and Peru are closely adapted to their different altitudes, only a few sorts yielding good crops in the tropical lowlands.

^b "It has been erroneously stated that maize was the only species of grain known to the Americans before the conquest. In Chile, according to Molina, the *mager*, a species of rye, and the *tuca*, a species of barley, were both common before the fifteenth century, and as there was neither rye nor barley in pre-Spanish America it is evident that if they were common, even after the conquest, and not European grain, they were indigenous. In Peru the bean (two or more species) and quinoa were common before the conquest, for I have frequently found them in the huacas, preserved in vases of red earthenware." (Stevenson's Travels, Vol. I, pp. 336-367.)

There are, however, many indigenous species of barley (*Hordeum*) in South America, some seventeen being listed as valid in the *Index Kewensis*. It is not impossible that some of these were cultivated, or at least utilized, before the coming of the Spaniards. It might have taken very little time for such a crop to be replaced by barley brought from Europe.

Quinoa, like the root crops, is inedible when raw. It contains an extremely bitter substance which has to be removed by long cooking, during which it is customary to change the water eleven or twelve times.

As long recognized by historians and ethnologists, maize was the most important factor in the material progress of ancient America, and the American civilizations remained on a much more strictly agricultural basis than those of the Old World, a fact not without practical significance to modern agriculture, since it undoubtedly conduced to the more careful selection and improvement of the many valuable plants which we owe to the ancient peoples of America. Subordinate only to maize from the agricultural standpoint was the domestication of the beans, while the materials for a developed culinary art and a varied and wholesome diet were furnished by a variety of minor products, like the Cayenne pepper, the tomato, the tree tomato (*Cyphomandra*), the pineapple, several species of the strawberry tomato (*Physalis*), the paw-paw (*Carica*), the granadilla (*Passiflora quadrangularis*), the gourd, the squash, and the peanut. American fruit trees, such as the custard apple and related species of *Annona*, the avocado (*Persea*), the sapodilla, *Mammea* and *Lucuma*, afford refreshing acids, beverages, relishes, or salads, but do not furnish substantial food like the banana. Contrary to the opinion of De Candolle there is every probability that the banana reached America from the west long before the arrival of the Spaniards, but it evidently did not come until after the agriculture and cultivated plants of America had spread into the Pacific.

NO PASTORAL PERIOD IN AMERICA.

Relying on the traditions of the peoples of western Asia and the Mediterranean region, many writers have assumed that animals were domesticated before plants, and that a pastoral stage marked the first step of primitive man from savagery toward civilization. There are, however, no indications of such a period in the agricultural history of the ancient peoples of America, nor among the "oriental" nations of the Asiatic shores of the Pacific and Indian oceans. The straight-haired men of both continents were primarily domesticators and cultivators of plants. The Chibcha people of the interior of Colombia attained a considerable degree of advancement without adopting a single domestic animal. The Peruvians and Chinese learned to use beasts of burden and animal fibers and skins, but their pastoral efforts were merely incidental to agriculture; they remained essentially vegetarians, eating little meat, other than fish, and never taking up the use of milk.

A settled agricultural existence made it practicable, however, to tame animals, and it may well be doubted whether any animal, with the possible exception of the dog, was domesticated by wandering savages. The lack of useful domestic animals in ancient America has been discussed by Payne^a and other historians as an evidence of the

^a History of the New World called America, Vol. II.

inferior intelligence and resourcefulness of the aboriginal peoples, but it seems that one tribe or another had domesticated all the American animals likely to be of value to civilized man; certain it is that Europeans, with three centuries of opportunity, have not added to the number or uses, or extended the range of any American animals, except the turkey and guinea pig. On the other hand, the American Indians have not failed to appreciate the superiority of the domesticated animals brought by Europeans, and the more enterprising tribes have adopted the hen, cat, pig, goat, sheep, cow, and horse. Indeed, even nonagricultural Indians of our Western States have taken kindly to the keeping of herds of sheep and cattle, and have thus assumed the pastoral state, illustrating, perhaps, the manner in which, in ancient times, domesticated animals spread more rapidly than cultivated plants from the agricultural East into the Mediterranean region.

Nomadic hunters or fruit eaters would not be likely to domesticate anything themselves, but offered the choice of plants or animals already thoroughly tamed and improved by selection, they are more likely to take the animals first as requiring a less radical change of food and habits of life. The milk and flesh of their herds would still be supplemented by the game, honey, wild fruits, and other edible plants which might be encountered in searching for pasture for their flocks, after the manner of the patriarchs of the Old Testament. Dates, figs, and other fruit trees might receive some attention from such wanderers, but the more successful they might become as shepherds the less likely they would be to take up the planting of cereals or of other herbaceous crops, which, in the absence of fences, would be appropriated by their animals before the owners could make even an initial experiment. It is accordingly significant that the origin of the agricultures and civilizations of the valleys of the Nile and Euphrates is no longer sought by ethnologists with Semitic shepherds or more northern peoples, but with a seafaring race which has been traced to southern Arabia, and whose language has been found to have analogies with the primitive Malayo-Polynesian tongue of Madagascar.^a

OTHER INDICATIONS OF TRANS-PACIFIC COMMUNICATION.

The American origin of agriculture could ask for no more striking testimony from Old World archaeology and ethnology than the recently discovered fact that the primitive culture race of Babylonia, which brought "letters, astronomy, agriculture, navigation, architecture, and

^a Keane (*Man, Past and Present*, p. 250 et seq.) considers the language of Madagascar to be Polynesian rather than Malayan, and holds that the similarities between Madagascar and Arabia are not due, as has been supposed, to a recent contact during the Mohammedan period, but date back to the ancient Mineans and Sabæans, maritime peoples who had commerce with India, and who are now supposed to have worked the prehistoric mines of the South African "Ophir."

other arts," was "a short, robust people, with coarse, black hair; peaceful, industrious, and skillful husbandmen, with a surprising knowledge of irrigating processes."^a

It is a long reach from Babylonia to tropical America, but the community of ancient food plants will prevent biologists, at least, from passing as a meaningless coincidence the fact that these early agricultural civilizations of Asia differed in no essential respect from those of our own so-called New World, not even in the physical characteristics of the people, so that the same words describe both equally well. If it be found that the same taro plant was in reality cultivated in ancient Egypt, Southern Arabia, Hindustan, Polynesia, and America, ancient human communication between these remote parts of the world is as definitely established as though coins of Alexander the Great had been dug up. It is no empty fancy, but the most direct and practical explanation of concrete facts, to believe that the robust, straight-haired race may have brought from America some of the plants they cultivated in Asia. It was among such men that agriculture, navigation, and other arts of civilization reached high development in America at a very remote period. The ancient cultures of the Old World left traces of no such infancy and gradual growth as those of America. Egypt and Babylonia arose suddenly to civilizations further advanced than those of Mexico and Peru.

That the Aztec and Inca empires were comparatively recent political organizations has caused many writers to forget that they incorporated much more ancient culture. For centuries still unnumbered the Andean region of South America supported crowded populations. On the western slopes of Peru every inch of irrigable land was cultivated—houses, towns, and cemeteries being relegated to waste places to save the precious soil. Irrigation was practiced with a skill and thoroughness unexcelled in modern times, though by methods closely duplicated in ancient Arabia, even including the boring of deep tunnels for collecting subterranean water.

To claim that the Polynesians, Malays, Phœnecians, Egyptians, Hindoos, or Chaldeans came from America would be a careless anachronism, to say the least, for the very terms of the problem place its solution far beyond the period in which these peoples, nations, and languages were differentiated. It is doubly unreasonable to expect any very close resemblance of languages or arts in the Tropics of Asia and America at the time of their discovery by Europeans, since change and diversification had continued on both sides of the Pacific. To accomplish the dissemination of the tropical food plants there was necessary only a primitive people with the skill in agriculture and navigation possessed by the Polynesians and Malays. It has long been

^a Keane, *Man, Past and Present*, Cambridge, 1899.

admitted by ethnologists that the remote ancestors of these races did overrun all the Tropics of the Old World, and the latest investigations warrant the belief that they made their influence felt also along the shores of the Red Sea and the Persian Gulf, where the civilization of the Mediterranean countries was formerly thought to have originated.

It can not be declared impossible, of course, that this primeval migration from America took place at a time when there was more land in the Pacific than now, as Belt and other geologists have held that there was, some thousands of years ago, but such conjectures are rendered gratuitous in view of the highly developed seafaring talents of the inhabitants of the Pacific islands and of the adjacent shores of America, from Alaska to Tierra del Fuego. It is no farther from America to the inhabited islands of the Pacific than from Tahiti to Hawaii, a route traversed by the Polynesians.^a In ancient, as in modern times, the sea was not a barrier, but the most open way of communication between distant regions; then, as now, the boat was the easiest means of transportation known to man. In time and labor of travel the islands of the Pacific were far nearer to Peru, for example, than many of the inland regions conquered by the Incas of Cuzco. Moreover, the Peruvians told the Spaniards of inhabited islands in the Pacific, or at least gave sailing directions which enabled Quiros to reach the Low Archipelago. There was a tradition that one of the Incas had made a voyage of two years in the Pacific and returned with black prisoners of war. Apparently, too, they told the Spaniards that the banana was brought from this quarter, for Acosta gathered from the Indians that it was not a native of America but came from "Ethiopia." These historical incidents have been overlooked or disregarded, perhaps because such possibilities as an American origin of agriculture and a trans-Pacific dissemination of food plants have not been considered by writers on primitive man. The times, routes, and methods of travel are, of course, questions to be approached by detailed studies of many kinds. For the present purposes it suffices to remember that the actual introduction of plants by human agency discounts in advance all objections on the ground of distances and difficulties of communication, and justifies the fullest use of biological or other data in tracing the origin and dissemination of agricultural civilization in the Tropics of both hemispheres.

The distribution and the uses of tropical cultivated plants support, it is true, the belief of ethnologists in the truly indigenous character of the peoples, agricultures, and civilizations of the western hemisphere, but they also testify to a very early colonization of the islands and coasts of the Pacific and Indian oceans from tropical America.

^aThe similarity of Polynesian culture to that of ancient America has been discussed at length in Lang's *Polynesian Nation*, Ellis's *Polynesian Researches*, and Rutland's *History of the Pacific*.

Botanical evidence makes it plain that most of the plants shared by the people of the two continents originated in America, like numerous other cultivated species which remained limited to this continent. The primitive culture peoples of the tropical regions of ancient America were accustomed to the cooking, grinding, and storing of vegetable food, and were thus prepared to appreciate and utilize the cereals by agricultural experience lacking among the fruit-eating aborigines of the Old World, where there seems to have been no tendency toward a spontaneous development of agriculture. Civilizations have nowhere developed without the assistance of the farinaceous root crops and cereals, the use and cultivation of which are habits acquired by primitive man in America and carried in remote times westward across the Pacific, together with the social organization and constructive arts which appear only in settled communities supported by the tillage of the soil.

